Faculty of Engineering, Architecture and Built Environment
Engineering School
Chemical and Petroleum Engineering Department
HYEP - HYET - HYEG

Answer all the questions			Marks allocated
Q 1	a	Define the following terms:	
		A high boiling azeotrope : a solution of two liquid component & at some composition it has a boiling point higher than any of the two pure components	2
		Ideal solution: any solution which obeys Raults law at all concentrations	2
		Mole fraction: the ratio of the moles of one component divided by the sum of all moles of all components	2
		State function: any property which depends on the initial and final states only.	2
		Triple point: a point at which all three phases of matter are present. It is an invariant point i.e it has no degrees of freedom.	2
	b	1. The van der Waals constant, **a**, in the relationship $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$ is a factor that corrects for: a. deviations in the gas constant, R. b. the attractive forces between gas molecules. c. the tendency of the gas molecules to ionize. d. the average velocities of the gas molecules. e. the volume occupied by the gas molecules.	2
		2. The van der Waals constant, **b**, in the relationship $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$ is a factor that corrects for: a. deviations in the gas constant, R. b. the attractive forces between gas molecules. c. the tendency of the gas molecules to ionize. d. the average velocities of the gas molecules. e. the volume occupied by the gas molecules.	2

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3. The mass percentage composition of dry air at sea level is approximately N_2: 75.5; O_2: 23.2; Ar: 1.3. What is the partial pressure of each component when the total pressure is 1 atm?

(Given that atomic mass for O=16, N=14 and Ar = 40)

The amounts of each type of molecule present in 100 g of air, in which the masses of N_2, O_2, and Ar are 75.5 g, 23.2 g, and 1.3 g, respectively, are:

$$n(\mathrm{N_2}) = \frac{75.5\ \mathrm{g}}{28.02\ \mathrm{g\ mol^{-1}}} = \frac{75.5}{28.02}\ \mathrm{mol}$$

$$n(\mathrm{O_2}) = \frac{23.2\ \mathrm{g}}{32.00\ \mathrm{g\ mol^{-1}}} = \frac{23.2}{32.00}\ \mathrm{mol}$$

$$n(\mathrm{Ar}) = \frac{1.3\ \mathrm{g}}{39.95\ \mathrm{g\ mol^{-1}}} = \frac{1.3}{39.95}\ \mathrm{mol}$$

- These three amounts work out as 2.69 mol, 0.725 mol, and 0.033 mol, respectively, for a total of 3.45 mol. The mole fractions are obtained by dividing each of the above amounts by 3.45 mol and the partial pressures are then obtained by multiplying the mole fraction by the total pressure (1.00 atm):

	N_2	O_2	Ar
Mole fraction:	0.780	0.210	0.0096
Partial pressure/atm:	0.780	0.210	0.0096

- We have not had to assume that the gases are perfect: partial pressures are defined as $p_J = x_J p$ for any kind of gas.

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<td>Q 2</td>
<td>a</td>
<td>i Derive the phase rule (P+F=C+2)
ii Define each term in the phase rule</td>
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<td>b</td>
<td>Use the following equilibrium diagram to explain the following cooling curves. Your answer must include phase reactions.</td>
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